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From: Information Control, OSO

Country: Germany (Russian Zone)

Subject: Technical Data on OSW Cathode Ray Tube

The attached photostats concerning technical data on the OSW Cathode ray tube #2066 are sent to you for your information and retention. 25X1

25 YEAR RE-REVIEW

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High Performance Cathode Ray Tube

Type OSW 2066

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Oberspreewerk

Berlin - Oberschoeneweide

Ostenstrasse 1 - 5

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Content: <u>Copy of the Construction and Experimental Report for the High Performance Cathode Ray Tube Type OSW 2066 Developed in the Period May 8, 1945 to June 1946</u>.

The High Performance Cathode Ray Tube, OSW 2066, was developed at O.S.W. during the first half of 1946 as an improvement on the earlier AEG and Siemens types. The tube fulfills the requirements of the original problem. The tube is of national economic importance. After October 22, 1946 OSW - Berlin will no longer construct this pattern. The general production and eventual further development will be transferred to the U.S.S.R. after this date.

High Performance Cathode Ray Tube OSW 2066

I. Statement of Problem

The problem of building a high performance tube similar to the AEG Type HRP 1/130/20 or the Siemens Type E115 was presented: The first step planned was the Type 2066 with a writing speed of 20,000 km/sec at 20 kV anode potential. Another problem should take up from here to develop higher writing speeds.

II. General Constructional Criteria

Realizing that at anode voltages of 20 kV the AEG type presents no happy solution to the problem because of its many corners and points and that, on the other hand, the complicated glass technique employed in the Siemens construction is just as uninviting, we decided to employ a new design. The foundation chosen was a four ceramic brace system, the parts however are made according to a new design. The individual electrodes are comprised of one or more drawn screening pails, so constructed that they may be centered by their flanges in a centering jig. Clips, so oriented that their tabs point to the corresponding electrode, are used to fasten these pails. In this way corona at their tips is reduced. The use of pin contacts in the pressed base as well as the neck of the tube makes for a simple and low capacity type of construction. The mechanism is so well supported by the pins that the spring rim used in the AEG tube, which unfortunately raised the capacity, is replaced by four springs mounted on the brace members and making contact to the (carbon) black coating on the wall of the tube.

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The electron-optical system of the GSW 2066 is a so-called screen grid system. The electrons emanating from cathode K pass through the opening of the pail-like control grid, g_1. This electrode acquires a slightly negative bias with respect to the cathode. Following the control grid is the screen grid, g_2, whose function is to draw electrons out thru the control grid. Next, is the lens forming electrode a_1, which is built in the form of a cylinder and which has an iris at the front end. This iris has the function of collecting electrons which have departed too far from the ray center. These would produce a large fuzzy spot on the screen. By using a screen grid between the lens forming electrode, a_1, and the control electrode, g_1, a change of beam current with changes in the focusing voltages is prevented. Electrode g_2 is kept at a high potential, whereas, electrode a_1 has a somewhat lower voltage. Following the lens forming electrode, a_1, is another cylindrical electrode a_2 of larger diameter. The major focusing action takes place between electrodes a_1 and a_2. The focusing of a beam onto the screen is essentially dependent upon the potential difference of electrodes a_1 and a_2. The essential difference of this kind of optics is the relatively larger diameter of the lens forming electrode in the region of the main collecting lens as compared with earlier high performance tubes.

In regard to the deflection system two important requirements must be considered. The signal deflection plates must be decoupled from the lens system electrodes and the other set of deflection plates. In addition the leads to the signal plates must have a minimum of associated capacitance and inductance. To fulfill the first requirement, a large screening iris (shutter) which was to be at anode potential was brought in front and behind the signal deflection plate pair. For lead-in wires to the deflection plates, pins were sealed into the neck of the tube, to which contact was made by springs as the mechanism was pushed into place in the tube. Accordingly, the leads become very short and unnecessary stray capacitance and inductance is avoided. The dimensions of the deflection plates were so chosen that the total screen was covered without appreciable distortion due to deflection error.

In order to remove errors due to the fringing field slit irises were installed at the input and outlet edges of the signal plates and at the input edge of the time base deflection plates.

III. System Construction.

The system is constructed on a hard glass pressed base containing sealed-in tungsten pins (see Drawing R23-03). It consists of the cathode structure with control grid pail and screen grid pail and the electron optical system including the deflection plates.

(a) <u>Cathode structure.</u>

The essential parts of the cathode structure (see Drawing R23-05) are the cathode itself, with the control grid pail and the screen grid pail inside which the ~~first~~ cathode is mounted.

The cathode contains a heater, 2 for 6.3 V, made of a drilled-out tube formed into a spiral and covered with an insulating paste of aluminum oxide. The leads to the filament are fastened to tube rivets, which are fastened to a ceramic disc with lock washers. The cathode consists of a small tube to which is welded a little hat which carries the emitting paste. The cathode tube has two flanges which are welded to springs. These springs clamp the cathode tightly to the supporting ceramic plate even though it is warped under alternate heating and cooling. A second ceramic plate is used along with the first to align and hold the cathode tube. The two ceramic plates (Ergan) are spaced by a ring. The ceramic plates are machined to fit.

The above described cathode is mounted in the control "pail" [grid] which is made of two welded parts, 3 and 4. The cathode is fastened to inwardly bent tabs on the control grid's lower member, 4.

The alignment and anchorage of the cathode system (see Drawing R 23.0305) in the screen grid pail, 2, is accomplished by the use of two ceramic discs 3 and 4 (Loetceramic) which are prevented from slipping out by three nubs. Disk number 3 is ground on both faces and on the inner and outer rims since it is used to center and space the control and screen grids.

Disk number 4, consists simply of pressed unfinished ceramic. With reference to the machining of the control grid pail it is important that the iris be highly polished and absolutely free of foreign matter. Furthermore the hole in the screen grid iris must be clean and free of grit. The control diaphram (iris) has a diameter of 0.85 mm and is located 1 mm from the screen grid diaphram which has a 4 mm diameter.

(b) <u>Lens System</u>

Beyond the screen grid at a distance of 2 mm is the lens electrode which consists of 4 diaphram-pails 9, 3, 10 (see Drawing R.23.03). The entrance iris has a diameter of 10 mm, the exit iris has a diameter of 26 mm. The length of the electrode is 57 mm. The two "getter" containers are fastened to the exit iris. Each contains two Bato-getters. At a 10 mm distance frompail number 10m there is an anode iris, 11, having a diameter of 10 mm, which along with the former produces the main focusing (concentrating) field for the beam. Between the anode pail 11 and the iris pail 13 there is the aperture iris, number 12, located 8 mm from the anode iris and having a 3 mm diameter.

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(c) Deflection System

The iris pail, 13, has a rectangular cut, which corresponds to the lower edge of the deflection pair, 14. The springs 4 and 5 serve as leads to these deflection plates. They are fastened to them with special holders. An iris, 15, having a rectangular slit lies next to the exit of the first pair of deflection plates. This iris carries spring number 6, used as lead to the anode. An iris pail, 16 is welded to iris 15, which (pail) acts as a slit iris for the second pair of deflection plates, 17. Finally, the springs, 18, are fastened to the outer ends of the ceramic braces. These are connected with the irises 15, 16 and 11, 12, 13 all of which are at anode potential. These springs serve, on one hand, as spacers for the system and the wall of the tube as well as a connection between the anode and the (carbon) black deposit on the wall of the tube. Copper-nickle wires 19, 20, 21 and nickle bands, 30 serve as leads from the pins in the press to the spring contacts. Similarly, the two anode systems are connected by a nickle band, 22.

(d) Fluorescent Screen

The fluorescent screen is circular and flat. It is covered with one of the phosphors manufactured by Leuchstoff G.M.B.H. of Steinbach, coded H-3 white-blue. This substance has a certain percentage of zinc-selenite which insures that at 20 kV the secondary emission factor is greater than unity, which avoids building up a charge on the screen. The phosphor is fastened to the surface of the glass by the help of an alcoholic phosphate solvant by the well known "Perl" (bead) method.

The color of the phosphor is a blue-white at the operating voltages and currents and lends itself to photographic purposes.

(e) <u>(Carbon) Black Coating</u>

The walls of the tube are coated with a film of electro-graphite, which had been ground and floated on water glass. The graphite coating has the same potential as the last electrode a_2. It is necessary to conduct the electrons which fall on the screen away, in order that the screen will not become negatively charged and hinder the arrival of the electrons in the beam. The discharge is performed by the graphite film which collects the secondary emission electrons from the screen as well as those which manage to leak across the 5 mm wide strip of un-coated glass between the screen and the graphite coating. Furthermore, the coating prevents charging of the glass wall of the tube by stray electrons.

IV <u>Pumping and Forming</u>

The best possible vacuum must be obtained during the pumping and heating procedure. At the maximum temperature of 415°C. the vacuum must be at least 10^{-6} mm Hg. After cooling the thusly evacuated tube the cathode is transformed, i.e. by heating, the carbonate of the emission paste is transformed to an oxide. Next the getter is flashed, and, finally, the formation or activation of the emitter is undertaken. Along with this, high voltages are applied between those electrodes which will have high operating potential differences, such as between the anode and the lens forming electrode. This is done to avoid the possibility of eventual dielectric breakdown.

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Finally the tube is put into operation and the screen is scanned by the beam to eliminate the residual gas in it. Then the getter is activated and the tube is sealed.

V. Placing in Operation

When placing the tube in operation it must be carefully observed that the cathode has reached its normal operating temperature, which is achieved in about 25 sec. of heating. Then the other electrode potentials may be applied. It is necessary to observe the ratings given in the data sheet if the tube life and sensitivity are not to be curtailed. Fixed, for example, synchronized figures etc. may not be produced at the rated current. A maximum of 5 kV may be applied to the screen grid. At anode voltages less than 5 kV, E_{g2} is taken as equal to E_a. The screen grid and lens electrode are so constructed that they accept no current. The prescribed cathode current is adjusted by changing E_{g1}.

VI. Experimental Results:

(a) Resistance to Voltage Breakdown

Investigation showed that a pulsed d-c voltage of about 25 kV between the lens system and the anode, the normal operating voltage difference is only 16 kV, caused no ionization or voltage breaddown.

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If the electrodes lying beyond the lens are tied together, and those lying before the lens, direction taken in the sense of the electron beam, are tied together and the above mentioned 25 kV potential is applied, the whole system shows no ionization or voltage breakdown.

(b) Deflection Sensitivity

The deflection sensitivity of the tube at an anode potential of 20 kV is 0.05 mm/V at the signal plates and 0.04 mm/V at the time base plates. The capacitance of the signal plates to each other is about 1.6 pF (uuf?) whereas the timing plates have a capacitance of 1.7 pF. The capacitance between the two systems is negligible because of the screening. It is 1.1×10^{-2} pF.

(c) Writing Speed

The writing speed of the tube was determined photographically. As there was neither an optical system available such as was used with the AEG tube to give 50,000 km/sec writing speed, nor an emulsion of corresponding sensitivity, the writing speed had to be approximately determined. An optical system 1:1.8 [f number ?] and commercially available movie film were used in making the photographs. Calculations, taking into account the unfavorable methods of measurement (photographic), gave a writing speed of at least 20,000 km/sec. Hence the aim of the development was fulfilled.

Enclosures: 5 Drawings R 23
R 23 (Ma)
R 23 · 03
R 23 · 05
R 23 · 0305

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VII. Technical Data

Technical Data on the High Performance Cathode Ray Tube Type OSW 2066

_ _ _ _ _ _ _ _ _ _ _ Anode Voltage 20 kV _ _ _ _ _ _ _ _ _ _ _ _ _ _

General:

Deflection:	double electrostatic
Screen color:	blue-white
Coating:	no after glow (low persistance)
Screen:	circular and flat
Cathode:	Heater potential $E_f = 6.3$ V (5.4 - 7.2V)
	Heater current $I_f \approx 0.5$A
	Oxide cathode, indirectly heated.

Capacitances:	Cathode	with	respect	to	all	other	electrodes	$C_k \approx 4.5$pF
	Grid	"	"	"	"	"	"	$C_g \approx 6.5$
	M_1	"	"	"	"	"	"	$C_{m1} \approx 4.5$
	Z_1	"	"	"	"	"	"	$C_{Z_1} \approx 5.0$
	Z_1	"	"	"	Z_2			$C_{z1/z2} \approx 1.7$
	M_1	"	"	"	M_2			$C_{m1/m2} \approx 1.6$
	Z_1	"	"	"	M_1			$C_{z1/m1} \approx .011$

The electrodes not concerned are grounded or put at the bridge neutral point in the measurement system.

Vibration strength at 1mm amplitude = 2g.

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Ratings

Anode voltage :	Ea_2 = 20 kV
Screen grid voltage:	Eg_2 = 5 kV
Signal plate voltage:	Vm = 800 V at 500 cycles
Timing plate voltage :	Vz = 800 V at 50 cycles.
Cathode current :	I_k = 30 uA (Eg_1 is regulated to give this value)
The lens voltage amounts to:	Ea_1 = 3.4 to 4.6 kV
The line width is :	B $\cong$ 0.5 mm
The writing speed is :	$\cong$ 20,000 km/s

Deflection Sensitivity

Anode voltage :	Ea_2 = 20 kV
Lens voltage :	Ea_1 = optimum
Screen grid voltage :	Eg_2 = 5 kV
Cathode current :	I_k = 2uA (Eg_1 is regulated to give this value)
The signal plate sensitivity is :	0.05 mm/V
The timing plate sensitivity is :	0.04 mm/V

Values at Pulse Operation:

Anode voltage :	Ea_2 = 20 kV
Lens voltage :	Ea_1 = optimum
Screen grid voltage:	Eg_2 = 5 kV
Cathode pulse current :	I_k = 1000 uA (Eg_1 is regulated to give this value)
Pulse time	$\tau = 10^{-4}$ sec.
Duty cycle	τ = 1:1000

The line width is : $B \simeq 1$ mm

Brightness:

Anode voltage : $Ea_2 = 20$ kV

Lens voltage : $Ea_1 = 4$ kV

Screen grid voltage : $Eg_2 = 5$ kV

Cathode current : $I_k = 15$ uA

Scanning area (Raster) 30 mm x 30 mm

Brightness value = 0.25 HK

Maximum Values:

Anode voltage : $Ea_2 = 22$ KV

Lens Voltage : $Ea_1 = 5$ kV

Screen grid voltage : $Eg_2 = 5$ kV

Grid blocking voltage : $Eg_{SPERR} = -200$ V

Grid voltage : $Eg_1 = 0$V

Signal peak volts : $V_{m_{sp}} = 2$ kV

Timing peak volts : $V_{z_{sp}} = 2$ kV

Cathode current : $I_k = 1500$ uA

Heater - Cathode voltage $E_{f/k} = 100$ V

Allowable Deviation:

Grid blocking voltage (Grid voltage at anode current cut off) $Eg_{sperr} = -200$ to -100 V

at $Ea_2 = 20$ kV, Ea_1 = optimum, $Eg_2 = 5$ kV

$Vm = 800$ V (500 cycles), $V_z = 800$ V (50 cycles)

the decay of the picture is watched with the unaided eye.

Cathode current : I_k = 1500 uA at Ea_2 = 20 kV

Ea_1 = 2 kV

Eg_2 = 5 kV

Eg_1 = 800 V

Vm = 800 V (500 cycles)

V_z = 800 V (50 cycles)

$\tau = 10^{-4}$ sec.

τ = 1:1000

Center deviation:

The focused but undeflected spot lies within a circle of 15 mm (diameter ?), lying at the geometric center of the tube's screen.

In this measurement care must be taken to screen the tube from all stray fields.

Axis deviation:

The plane through tube axis and pin A may deviate from the line produced by the deflection plates Z_1 and Z_2 by an angle of 10°. The deviation from 90° between the lines produced by the pairs Z_1, Z_2 and M_1, M_2 may be 5°.

Drawing with dimensions : Socket connections

(See p. 15)

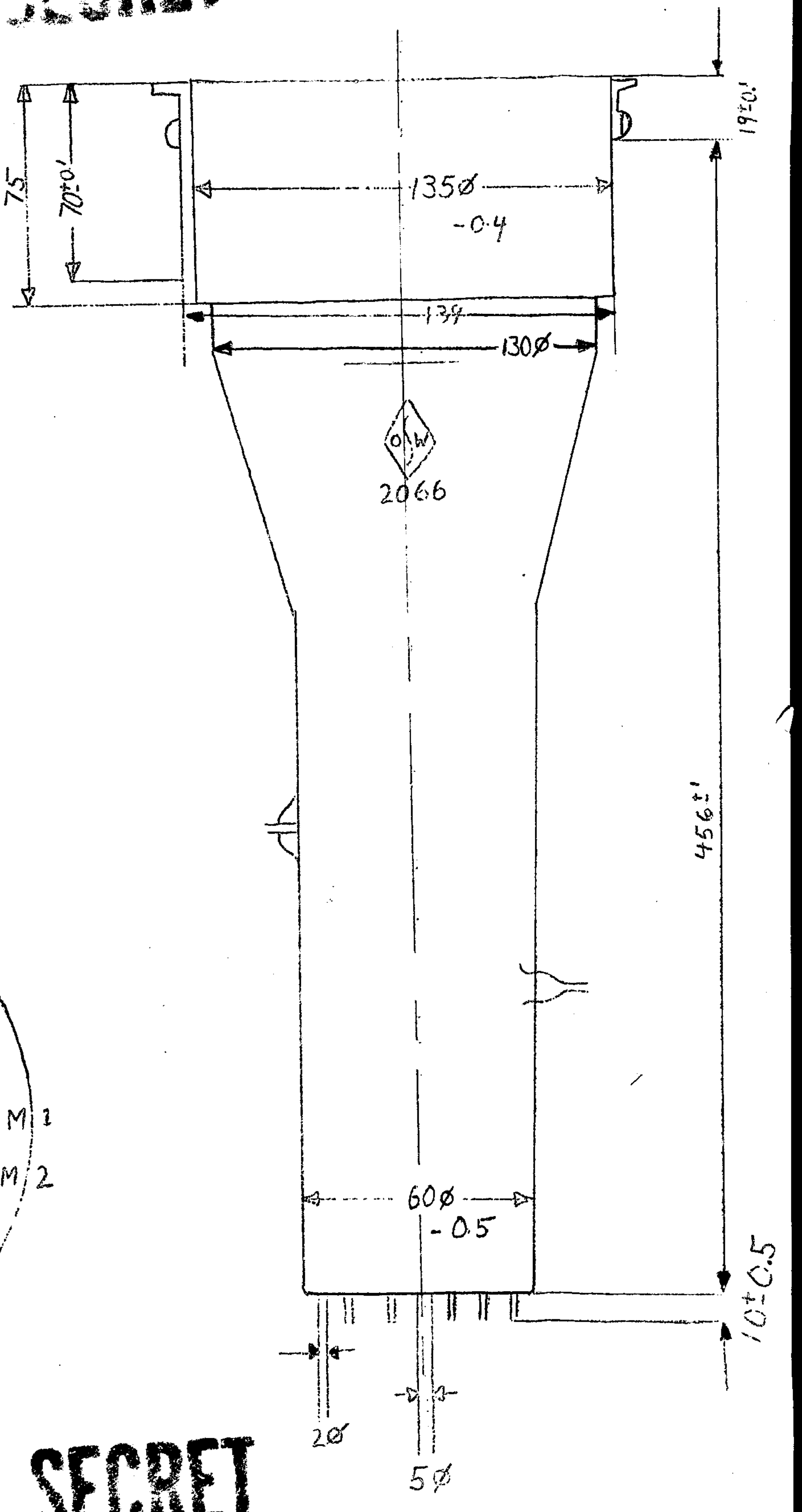

Diagram of socket connections